REMARKS

Favorable reconsideration of this application as presently amended and in light of the following discussion is respectfully requested.

Claims 1-9 and 11-27 are pending in the present application. Claims 1, 2, 3, 5, 7-9, 11-16, and 19-22 are amended, Claim 10 is cancelled without prejudice or disclaimer, and Claims 23-27 are added by the present amendment.

In the outstanding Office Action, Claims 1-9, 13, and 14 were rejected under 35 U.S.C. § 103(a) as unpatentable over U.S. Patent No. 5,838,021 to Ancona in view of U.S. Patent No. 5,963,471 to Ohata et al. (hereinafter "Ohata"); Claims 10 and 11 were rejected under 35 U.S.C. § 103(a) as unpatentable over Ancona in view Ohata and further in view of U.S. Patent No. 6,487,112 to Wasshuber; Claims 15-22 were allowed; and Claim 12 was objected to as being dependent upon a rejected base claim.

Applicants thank the Examiner for the indication of allowable subject matter. In view thereof, amended Claim 12 is rewritten to include the limitations of its base claim and any intervening claims. Accordingly, Applicants respectfully submit that amended Claim 12 is in condition for allowance.

As Claim 1 is amended to incorporate the subject matter of canceled Claim 10, the rejection of Claim 1, and Claims 1-9, 13, and 14 depending therefrom, is moot. Therefore, Applicants now address the rejection of Claim 10 as applied to amended Claim 1. That rejection is respectfully traversed.

Amended Claim 1 is directed to a logic apparatus having similar first and second single-electron devices. The first single-electron device includes, *inter alia*:

> a first conductive island insulatively disposed over the semiconductor substrate,

> at least two first tunnel barriers insulatively disposed over the semiconductor substrate, the first conductive island being interposed between the first tunnel barriers,
>
> first and second electrodes insulatively disposed over the semiconductor substrate, the first conductive island being coupled with the first and second electrodes through the first tunnel barriers, respectively, and
>
> a first charge storage region insulatively disposed over the first conductive island.

As stated, amended Claim 1 incorporates the subject matter of canceled Claim 10. Thus, amended Claim 1 now further recites that a Coulomb oscillation in a state that charges are accumulated in the charge storage region is shifted by a half period from the Coulomb oscillation in a state that no charge is accumulated therein.[1]

In a non-limiting example, Figure 9A illustrates an embodiment of the claimed logic apparatus. As shown in each of the single electron devices 106, 107, a charge storage region 5 is insulatively interposed between a conductive island 15 and a gate electrode 7. The insulation film 4 between the conductive island 15 and the charge storage region 5 serves as a tunnel insulation film 103.[2] Thus, by varying the potential of the gate electrode 7, electrons can be caused to shuttle between the conductive island 15 and the charge storage region 5. In this manner, the energy state of the conductive island 5 can be varied to shift the Coulomb oscillations of the single electron devices 106, 107.[3]

The size and materials of the conductive island 15 are chosen such that the Coulomb oscillation is shifted by a half-period when the charge storage region 5 is alternated between charged and uncharged states.[4] Thus, as shown in Figure 3, if charges are accumulated in the charge storage region 5 (see broken line), an output of Id and zero occurs when VL and VH,

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[1] For support, see canceled Claim 10.
[2] Specification, page 8, line 24-27.
[3] Specification, page 8, line 27 — page 9, line 2; page 9, lines 14-19.
[4] Specification, page 11, lines 8-12; page 12, lines 5-7.

respectively, are applied to the gate electrode 7.[5] Conversely, when no charges are accumulated in the charge storage region 5 (see unbroken line), an output of Id and zero occurs when VH and VL, respectively, are applied to the gate electrode 7.[6] Accordingly, four logic operations may be performed.[7]

The outstanding Office Action cites Ancona and Ohata as teaching the structure of the claimed invention; and cites Wasshuber as teaching the shifting of a Coulomb oscillation in accordance with whether charges are accumulated in a charge storage region.[8] More particularly, the Office Action states: (1) the device of Wasshuber inherently shifts a Coulomb oscillation "by some period" in accordance with the size and materials of a single-electron device; and (2) the combination Ancona and Ohata teaches a device having the same structure and materials as the claimed invention, which would thus inherently produce a half-period shift.[9]

First and foremost, Applicants note that neither Ancona nor Ohata states that their device was designed to induce a half-period shift. Further, even assuming Ancona and Ohata teach a device having the same structure and materials as the claimed invention (not admitted), the dimensions of that device must also be identical to those of the claimed invention to produce a half-period shift. There is no such indication of identical dimensions within the references and Claim 10.

In sum, if the Office Action is asserting that the device of Ancona and Ohata inherently shifts a Coulomb oscillation by a half-period, then Applicants respectfully request a stated basis in fact or technical reason as to why a half-period shift (in particular) must

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[5] Specification, page 12, lines 12-15.
[6] Ibid.
[7] Specification, page 20, lines 18-27.
[8] Office Action, 12/31/2003, pages 5.
[9] Office Action, 12/31/2003, pages 5-6.

result.[10] Alternatively, if the Office Action is asserting that a half-period shift would be obvious in view of the applied references, then Applicants respectfully request a stated motivation (either in the reference or knowledge generally available to one skilled in the art) for shifting the Coulomb oscillation by a half-period (in particular).[11]

Accordingly, as the configuration of the device taught by Ancona and Ohata neither dictates a half-period shift nor is identical to the claimed invention, and as the Office Action states no proper basis or motivation for a half-period shift, Applicants respectfully request that the rejections of Claims 1-9, 11, 13, and 14 be withdrawn.

Applicants further note that dependent Claims 3 and 5 further recite that the first and second single-electron devices each include a gate electrode (*i.e.*, the fifth and sixth electrodes) insulatively disposed over their charge storage regions.[12] Thus, the single-electron devices of Claim 23 have two conductive regions (*i.e.*, the gate electrode and charge storage region) arranged over their conductive islands. None of the applied references teaches such a feature.[13] Further, Applicants note that both conductive regions have distinct purposes (explained *supra*) that cannot both be achieved by either Ancona's single capacitor 18 of Figure 1 or Ohata's gate electrode of Figure 18.[14] Accordingly, Applicants respectfully submit that dependent Claims 5 and 6 further distinguish over the applied references.

New Claims 23-27 are added to recite the present invention in a varying scope. More particularly, new Claims 23-27 are similar to Claims 1, 3, 5, 7, and 12, respectively, but recite the charge storage regions in means-plus-function format. Accordingly, new Claims 23-27 are believed to distinguish over the applied references for the same reasons as Claims 1, 3, 5, 7, and 12.

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[10] See MPEP § 2112.
[11] See MPEP § 2143.
[12] For support, see Specification, page 8, lines 10-18 and Figures 9A and 13A.
[13] Office Action, 12/31/2003, pages 2-3.
[14] Office Action, 12/31/2003, page 2.

Consequently, in light of the above discussion and in view of the present amendment, the present application is believed to be in condition for allowance, and an early and favorable action to that effect is respectfully requested.

Respectfully submitted,

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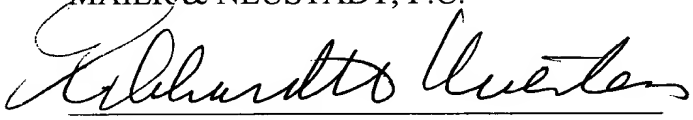

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